AN AUTOMATED SYSTEM FOR CLOSED-CHAMBER DRILLSTEM TESTING

Don K. Poulsen
Halliburton Services

Alvey O. Bass
Halliburton Reservoir Services

ABSTRACT

Software and a manifolding system for automating closed-chamber drillstem tests have been developed. This paper describes the software, the manifolding and, briefly, the data acquisition system that provides the interface between them. In addition, it presents improved correlations for determining the maximum influx rates of gas-free and gas-saturated water.

The typical test procedure is outlined in the paper and an actual example of a closed-chamber test illustrates the paper.

INTRODUCTION

Closed-chamber drillstem testing, introduced by Alexander,[1,2] was developed as a method of testing wells safely under hazardous conditions present in the Arctic.[3] In addition to safety, Reid and Alexander[3] have listed secrecy, instantaneity, precision, permanent documentation, and flexibility as advantages of the closed-chamber technique over conventional drillstem test (DST) methods.

By monitoring and analyzing closed-chamber tests using the manifolding system and the computerized data acquisition system described in this paper, several of these advantages are significantly improved upon.

The near instantaneity of a closed-chamber DST, which occurs because surface pressures can be read and plotted as fluid is produced into the drillstring, is improved upon by automating the tedious process of reading gauges and plotting data points on a pretest planning graph. In addition, gas and liquid influx rates can be calculated and plotted automatically, increasing the speed at which data can be analyzed and decisions made at the wellsite.

Precision and analysis are improved through the direct reading of any of three pressure transducers, each for a different pressure range, and by using improved correlations and a more reliable method of estimating pressure derivatives. By tapping the pressure at the control head instead of at the floor-choke manifold, chicksan hoses and swings are eliminated, thus reducing the potential for errors resulting from pressure leakage.

The manifolding also improves safety by keeping the transducers in a relatively safe area away from the rig floor.

And, by allowing collected and calculated values to be printed while the test progresses and a report to be printed or saved on magnetic disk after the test ends, documentation is improved. In addition, "hard" copies of pressure data plotted on the pretest planning graph and of graphs of collected pressures or calculated flow rates plotted against time may be produced.

HARDWARE

Data Acquisition System and Computer

A portable, suitcase-sized data acquisition system designed for cementing and stimulation work is used for the closed-chamber testing (Fig. 1). Based on a Motorola 68000 microprocessor and powered by a 12V car battery or any 110 or 220 VAC power source, the data acquisition unit is capable of monitoring three pressure, one temperature, three flow rate and one density transducer(s) at a frequency of 1 sample/sec. For a closed-chamber DST, only the three pressure transducers are monitored.

The processed information is sent to an IBM-PC AT-compatible GRiD 1520 computer that uses a high speed Intel 80286 microprocessor and an 80287 math coprocessor. It is this computer on which the closed-chamber testing software is run.

Included in the data acquisition system is a compact Diconix model 150 inkjet printer. Additional hardware may be attached to the system, such as an external overhead display unit with six backlit LCD displays.

Pressure Manifolding

Four goals were set for design of the pressure manifold system.

1. Provide a set of transducers to cover the range of pressures found on most tests in the Permian Basin (i.e., from oz/sq in. up to 2000 psi).

2. Locate the transducers in a relatively safe area away from the rig floor.

3. Tap the chamber pressure at the control head instead of the floor-choke manifold, thereby eliminating chicksan hoses and swings, and reducing the potential for pressure leakage.

4. Allow components to be removed for servicing relatively easily.

The pressure manifold system (Fig. 2) for achieving these goals consists of (1) a pressure transducer manifold system (Fig. 3), (2) two 50 ft sections of 10,000 psi Martin Decker rubber hose to be used as conduit for transmitting chamber pressure from the control head or floor-choke manifold to the pressure transducer manifold system, (3) a needle valve arrangement to connect the two hose sections and to provide positions for pressure gauges and an outlet for the bubble hose, and (4) a valve arrangement to connect the rubber hose to the control head.

The pressure transducer manifold system (Fig. 2) consists of (1) three Dynisco transducers with 4-20 mA output and ranges of 0-50, 0-250, and 0-3000 psig and accuracies of 0.25% of full scale, (2) a needle valve for each transducer to isolate it as it reaches its upper end, and (3) positions for installing liquid-filled dial gauges used to confirm proper transducer operation and to provide backup.

An aluminum box houses the transducer system and can also be used to store other components.

One section of the rubber hose runs from the control head, which could be located anywhere from floor level to 30-40 ft up in the derrick, to the needle valve arrangement. The second section runs from the needle valve arrangement to the pressure transducer system. If desired, the needle valve arrangement could be modified slightly so as to allow it to tap into the choke manifold, in which case only one hose section would be required.

In addition, three 20 ft lengths of transducer cable connect the transducers to the data acquisition system.

SOFTWARE DESIGN

The main goal of the data acquisition and analysis software is to automate the acquisition of data from a closed-chamber DST. This not only decreases the work involved in the testing but allows faster presentation of the results which, in turn, allows testing decisions to be made more quickly. Toward this goal, a number of capabilities were implemented in the software.

1. Create an on-screen log-log diagnostic (pretest planning) plot displaying maximum possible surface pressures for gas, gas-free water and gas-saturated water influx versus time.

2. Acquire surface pressure data from any of three pressure transducers and instantaneously display the data points on the diagnostic plot.

3. Digitally display on screen time and the pressures from the three transducers as they are read.

4. Handle multiple flow periods, each with its own diagnostic plot.

5. Allow "hard" copies of the diagnostic plots, with or without data, to be made.

6. Allow for a water cushion to be considered.

7. Display time, pressure as read from each transducer and the first and second derivatives of pressure on an auxiliary overhead display as data are collected.

8. Print pressures, pressure derivatives and calculated gas and liquid flow rates as data are collected.

9. Save on magnetic disk the data and calculated rates in an IBM-format ASCII

file as they are collected.

10. Create a printed report of the collected and calculated data.

11. Save on magnetic disk time-pressure-temperature data in a binary file readable by the reservoir evaluation system discussed by Shuman et al.[4]

12. Plot surface pressure, calculated gas flow rate or calculated gas-free liquid flow rate versus time on the screen or on paper.

13. Allow units used for data entry and output to be individually selected by the user.

Additionally, the program was to be easy to learn and use, using on-screen menus similar to those of Shuman et al.[4]

The software was written in Logitech's implementation of the Modula-2 language. Modula-2 was chosen because (1) it is highly structured and modular, thus allowing program features to be easily added or modified and making coding easy to understand, and (2) it still allows information to be manipulated at a very low level, if desired. In addition, using Modula-2 allowed the program to share procedures previously written for the IBM PC-compatible version of the reservoir analysis system[4] mentioned earlier. Graphics procedures were written to use lower-level graphics procedures provided by the Halo '88 software of Media Cybernetics.

Operator Interface

The software was designed to operate much like a previously developed reservoir analysis system,[4] being menu driven and requiring only one or two keystrokes to select commands or options from a menu (Figs. 4-6). The available commands are listed on the top line (the command line) of each menu and are executed by pressing the key corresponding to the capitalized letter of the command, usually the first letter of the command. Some of the more common commands are listed in Table 1.

Some of the menus (Fig. 4) also contain a list of options. These options may be selected by typing the index number corresponding to the desired option. Once an option has been selected, the M(enu) command will return the user to the screen from which the option was selected.

Screens designed for data entry (Figs. 5 and 6) have modifiable fields, some of which contain default values which may be used or replaced. These fields are reached with the I(nput) command. Once the program is in the input mode, the user can move between fields using the arrow keys (→, ←, ↑ and ↓). In a given field, the user may enter only characters or values valid for that field. Any of the fields may be reentered as often as the user desires while the program is in the input mode. Once everything desired has been entered, a single keystroke takes the program out of the input mode.

Transducer Calibration and Selection

As previously discussed, pressures may be read from any of up to three pressure transducers during a test. The transducers are calibrated from the Calibration menu (Fig. 6), reached from the Initialization menu (Fig. 4) by typing 6. After entering the input mode, the zeros and spans of any or all of the three transducers may be set.

The transducer voltage corresponding to 0 pressure can be typed in or may be set using the autocalibrate function. Autocalibrating is done by ensuring that the transducer senses zero pressure and then typing A while the cursor is in the Zero field. The data acquisition system then reads the voltage across the transducer and the program enters the value in the Zero field. The span values must be typed in by the user. Since each transducer will register the range of 1 to 5V, the zero value will be approximately 1V and the span value will be 1/4 of the transducer's pressure range.

The Calibration screen also allows the user to determine from which transducer initial readings are to be taken. The choice of transducers may be changed while data are being collected by typing 1, 2, or 3 to indicate the choice of the new transducer, thus allowing the different pressure ranges of the transducers to be taken advantage of.

The user may also select the interval between collected data points. The shortest interval allowed is 1 sec, which corresponds to the rate at which the data acquisition system reads the transducers.

Pretest Planning/Diagnostic Graph

More often than not, surface pressures measured during a closed-chamber DST are plotted on a log-log graph that contains curves showing the maximum possible surface pressures for gas-free water flow, gas-saturated water flow, and pure gas flow, listed here in order of increasing pressure. By plotting the collected pressures and comparing them to the curves, some indication of the fluid being produced may be obtained. For example, data points appearing above the maximum gas-free water influx curve would indicate some gas production; data points appearing above the maximum gas-saturated water influx curve would indicate the production of some free gas. If all points fall below the maximum gas-free water influx curve, it is difficult to say what is being produced.

Reid and Alexander's[3] method of generating the curves is to determine the rate of pressure increase for the maximum possible influx rate at initial flow conditions and to assume the maximum rate remains unchanged. By using a constant maximum rate of pressure increase, they implicitly assume that (1) liquid flow into the chamber does not affect the volume that can be occupied by the gas (either the air initially present or the produced gas), (2) the rate of pressure change is unaffected by the current chamber pressure and (3) the pressure drop across the downhole choke is always sufficient to maintain critical flow.

By avoiding the first two of these assumptions, the appendix shows that when there is liquid influx, the chamber pressure resulting from maintaining the maximum possible influx rate is

$$P = \left(P_o + \frac{\overline{T}zq_G}{fq_L}\right)\left(\frac{V_o}{V_o - q_L t}\right)^C - \frac{\overline{T}z\ q_G}{f\ \ q_L} \tag{A-3}$$

where C is a proportionality constant relating average chamber pressure to surface pressure ($C = \overline{P}/P$ = constant). For gas-free liquid influx ($q_G = 0$), Eq. A-3 reduces to

$$P = P_o \left(\frac{V_o}{V_o - q_L t}\right)^C \tag{A-4}$$

For straight gas influx ($q_L = 0$),

$$P = P_o + \frac{\overline{T}z}{fV_o}\ q_G t \tag{1}$$

As a way of partially resolving the third assumption, we can limit the chamber pressure to being no greater than reservoir pressure.

Where the approximation of Reid and Alexander[3] gives three lines with unit slopes on the log-log graph, the method and equations given here give curves similar to those shown on Fig. 7. If the calculations necessary for determining the flow rate across the downhole choke when the pressure drop is less than that necessary for critical flow were included, the curves shown in Fig. 7 would not suddenly break over, but would asymptotically approach the horizontal line.

Generating the gas-saturated water influx curve requires determining the gas-water ratio for gas-saturated water at estimated reservoir temperature and pressure. Correlating the natural gas solubility data of Dodson and Standing[5] resulted in the following correlation, which predicts GWR values within 4% of the experimental values in the ranges of 100 to 250 °F and 500 to 5000 psia.

$$GWR = \frac{\exp[d_o + d_1\ \ln(P_R) + d_2(\ln(P_R))^2]}{5.61458331871} \tag{2}$$

where $d_o = -6.1449025 - 0.011385159\ T_R$,

$d_1 = 1.7895315 + 0.0021351757\ T_R$,

and $d_2 = -\exp[-4.2429660 + 0.60295162\ \ln(T_R) - 0.043553785\ (\ln(T_R))^2]$.

Rate Calculations

The rate of pressure change for gas entering a closed chamber is known to be

$$\frac{dP}{dt} = \frac{\overline{T}\ z}{f\ V}\ q_G \tag{3}$$

Therefore, the rate of pure gas influx can be calculated as

$$q_G = \frac{dP}{dt} \frac{fV}{\overline{T}z} \tag{4}$$

The rate of pressure change for liquid entering a closed chamber is

$$\frac{dP}{dt} = \frac{\overline{P}}{V} q_L \tag{5}$$

and thus the rate of gas-free liquid influx can be calculated as

$$q_L = \frac{dP}{dt} \frac{V}{\overline{P}} \tag{6}$$

If, in this case, the gas initially filling the chamber can be assumed to follow Boyle's law, then the current gas-filled volume, V, can be calculated as

$$V = V_o \frac{\overline{P}_o}{\overline{P}} \tag{7}$$

Therefore, influx rates for pure gas or gas-free liquid can be calculated if values of the time derivative of pressure are known.

The program determines the pressure derivative at each point using the weighted mean slope method on the point of interest and the data points read 1 sec before and after it. This, of course, results in a 1 sec delay before the slope and the rates can be calculated and reported. Similarly, the second derivative of pressure, shown on an optional overhead display, lags by 2 sec because the first derivatives for these same three points are required for its calculation. By using the weighted mean slope method, better estimates of the pressure derivatives and flow rates are obtained than if the $\Delta P/\Delta t$ value for the previous interval was used.

Pressure and Rate Graphs

After each data collection period (usually corresponding to a flow period), the program allows pressure, gas rate and gas-free liquid rate to be plotted as functions of time on screen and paper (Figs. 8-10). The axes on each graph are automatically scaled to fit the range of data, but a Z(oom) command allows the user to rescale the axes to include any desired data range. Among the uses of the zoom feature are graphing data for a single flow period or focusing on a particular segment of data to help delineate any sudden changes in slope. Since the graphing feature may be used after any data collection period, creation of the graphs, especially the printed copies, may be delayed until after the final flow period if desired.

TEST PROCEDURE

The usual procedure for conducting a closed-chamber DST using the manifolding and data acquisition systems described in this paper is as follows:

1. Set up the data acquisition system in the dog house on the rig. Connect the

system to a 12V battery, not to the rig's 110V supply. The rig's electrical system is not dependable enough to run a computer off of.

2. Execute the data acquisition software, entering the data required for making pretest calculations and calibrating transducers. Generate the pretest planning graph on the screen.

3. Hook in the rubber hose at the control head.

4. Close all surface valves to chokes, pit, etc. to form the closed chamber. (The bubble hose may be left open to provide an additional check for determining when the downhole tester valve opens.)

5. As soon as the downhole tester valve opens, close the bubble hose and begin monitoring pressure with the data acquisition software.

6. From the position of the surface pressure data on the pretest planning graph and the shape of the curve, determine the type of production. Knowing the type of production, use the appropriate column from the information printed during the test (Table 2) to determine the production rates.

7. When the downhole tester valve is closed, note the time and continue monitoring the surface pressure for a few minutes for evidence of gas breaking out of liquid. A continued pressure rise is usually evidence of gas evolving from gassified water or gassy oil. When a single phase is present in the chamber, pressure should stabilize rapidly.

8. Vent part of the surface pressure through a gas measuring device while continuing to monitor surface pressure. The actual liquid recovery can be determined fairly accurately with additional calculations.[3]

9. If additional flow periods are desired, modify the values used by the software for the pretest and rate calculations as necessary and generate a new pretest planning graph. Repeat Steps 4 through 8.

10. After pulling the test string and determining the true recovery and bottomhole flowing pressures, calculate liquid production rates for the flow periods. Use the actual liquid rates and the surface pressures gathered during the flow periods to more accurately determine the gas and liquid production records.

11. Use the production records to perform superpositional semilog reservoir calculations.

EXAMPLE

Figures 5-10 and Table 2 illustrate the second flow period of a closed-chamber DST performed on a well in Woodward Co. Oklahoma. Figure 5 shows the data entered into the software and subsequently used to create the pretest planning graph of Fig. 7. Note on Fig. 5 that the user told the program that a 7208 ft string of 4.5 in., 16.6 lb/ft drill pipe together with 2.25 in. drill collars formed the 7629 ft long chamber and that the chamber initially contained a water cushion of 1212.5 ft, formed during the previous flow period. Figure 6 shows that the user selected a 15 sec interval between readings and that he chose Pressure Transducer 1, the low range transducer, for the initial portion of the test.

The pretest planning graph with the three maximum rate curves and the collected data are shown in Fig. 7. The data, located well below the gas-free liquid curve, indicate probable liquid production with little or no gas production. This was born out after the first flow period (not shown) when the surface pressure did not continue to increase after the downhole valve was closed. The second flow period lasted 11 minutes at which time a surface choke was opened.

Knowing that the production fluid is liquid, the production rates and cumulative fluid volumes may be determined by examining the proper columns on the printed report (Table 2).

The Cartesian coordinate graphs of measured surface pressure, calculated gas-free liquid flow rate and calculated gas flow rate vs. time are shown in Figs. 8-10. The gas flow rate graph is, of course, not applicable since it has been determined that the production fluid is liquid. This graph does, however, illustrate the low gas rates that would have been necessary to get the measured surface pressure response.

Because the pressures in this case approach the accuracy limit of the 50 psi transducer used (i.e., 0.125 psi), the difference between any two pressure values read 1 sec apart falls well below the accuracy limit. Consequently, as can be seen in Table 2, the dP/dt values, which are calculated using such pressure differences, are somewhat unreliable and erratic as are the rates that are calculated from them (Table 2, Figs. 9 and 10). This points out that if fairly low chamber pressures are anticipated, such as may be the case when the formation produces liquid alone, a more sensitive transducer should be available. The recommended test procedure would then be to use the 50 psi transducer initially, and if, after the first few seconds, it became apparent that the rate of pressure increase was low enough, switch to the lower range transducer at that point.

CONCLUSIONS

1. Software has been developed for the acquisition of data during closed-chamber drillstem tests. The software improves the speed, accuracy and documentation of these tests while reducing the tedium of performing them.

2. Improved correlations for calculating the maximum possible surface pressures for gas-free water and gas-saturated water influx have been developed. These correlations show that it is simplistic to assume these pressures increase linearly with time.

3. A manifolding system for monitoring surface pressures has been devised. The system improves safety by allowing the transducers to be kept away from the rig floor and helps maintain test accuracy by decreasing the possibility of pressure leakage.

NOMENCLATURE

C = ratio of average chamber pressure to surface pressure

f = 285.90 °R•d•mcf/psi•min•bbl

GWR = gas-water ratio, Std bbl/bbl

P = surface pressure, psia

P_o = initial surface pressure, psia

P_R = reservoir pressure, psia

$\overline{P}$ = average chamber pressure, psia

$\overline{P}_o$ = initial average chamber pressure, psia

T_R = reservoir temperature, °F

$\overline{T}$ = average chamber temperature, °R

t = time, min

q_G = gas influx rate, mcf/d

q_L = liquid influx rate, bbl/d

V = chamber volume, bbl

V_o = initial chamber volume, bbl

z = gas z factor

REFERENCES

1. Alexander, L. G.: "Evaluation by Closed-Chamber Drill-Stem Well Testing," presented at the 24th Annual Technical Meeting of the Petroleum Society of CIM, Edmonton, Alberta, May 9-11, 1973.

2. Alexander, L. G.: "Theory and Practice of the Closed-Chamber Drill-Stem Test Method," paper SPE 6024 presented at the 1976 Annual Fall Technical Conference and Exhibition, New Orleans, Oct. 3-6.

3. Reid, H. W. and Alexander, L. G.: "Modern Concepts in Drillstem Testing," The Canadian Society of Petroleum Geologists, Calgary (1979).

4. Shuman, J. L., Ulloa, K., Wilkinson, B. C. and Petak, K. R.: "Enhanced Reservoir Evaluation System Analyzes Data From a Wide Range of Sources," paper SPE 16509 presented at the Petroleum Industry Applications of Microcomputers, Del Lago on

Lake Conroe, Montgomery, TX (June 23-26, 1987).

5. Dodson, C. R. and Standing, M. B.: "Pressure-Volume-Temperature and Solubility relations for Natural-Gas-Water Mixtures," Drilling and Prod. Prac., API (1944).

ACKNOWLEDGEMENTS

The authors thank the management of Halliburton Services and Halliburton Reservoir Services for allowing us to prepare and present this paper. We also thank Doug Finley for his assistance during software development.

APPENDIX

Maximum Surface Pressure with Liquid Influx

The rate of pressure change at the surface is the sum of the rates due to gas and water influx.

$$\frac{dP}{dt} = \left(\frac{dP}{dt}\right)_{gas} + \left(\frac{dP}{dt}\right)_{water} = \frac{\overline{T}z}{fV} q_G + \frac{\overline{P}}{V} q_L \tag{A-1}$$

where $f = 285.90 \ \frac{°R \cdot d \cdot mcf}{psi \cdot min \cdot bbl}$.

If we assume the gas and liquid influx rates are constant, which is to say that the pressure upstream of the choke is constant and the pressure differential across the choke is sufficient to maintain critical flow, we can separate variables and integrate.

$$\int_{P_o}^{P} \frac{dP}{\frac{\overline{T}z}{f} q_G + PCq_L} = \int_0^t \frac{dt}{V_o - q_L t} \tag{A-2}$$

Here, the average chamber pressure is assumed to be proportional to surface pressure ($\overline{P} = CP$, where C is the proportionality constant).

Performing the integrations and solving for P gives

$$P = \left(P_o + \frac{\overline{T}zq_G}{fq_L}\right) \left(\frac{V_o}{V_o - q_L t}\right)^C - \frac{\overline{T}z}{f} \frac{q_G}{q_L} \tag{A-3}$$

For gas-free water influx, $q_G = 0$ and Eq. A-3 simplifies to

$$P = P_o \left(\frac{V_o}{V_o - q_L t}\right)^C \tag{A-4}$$

Table 1
Keystroke Commands

Command	Action
M(enu)	Return to the next higher level menu.
C(ontinue)	Continue to the next section of the program.
I(nput)	Allow entry of data.
H(ardcopy)	Copy the graphics on the screen to the printer.
Z(oom)	Reset the axis limits on the graph.
R(eplot)	Draw the graph using the new axis limits.

Table 2
Example Test Report

Closed-chamber drill-stem test
Woodward Co., Okla.
Test 1
Flow period 2
Ticket #000000

Test Date: 23/Jul/89
Tested Interval: 7650.0 - 7800.0 ft

Chamber Volume: 91.2 bbl
Surface Temperature: 60 F
Reservoir Temperature: 150 F
Assumed Gas Gravity: 0.60

					Gas-Free Liquid		Gas
Point No.	Time hh:mm:ss	delta Time (min)	Surface Gauge Pressure (psi)	dP/dt (psi/min)	Cum. Volume (bbl)	Rate (bbl/d)	Rate (MCF/D)
1	10:38:43	0.00	0.130		0.00		
2	10:38:58	0.25	0.194	0.225	0.39	1976.9	10.4
3	10:39:13	0.50	0.244	0.113	0.69	981.9	5.2
4	10:39:28	0.75	0.283	0.487	0.93	4232.7	22.6
5	10:39:43	1.00	0.326	0.150	1.19	1294.8	6.9
6	10:39:58	1.25	0.368	0.150	1.44	1287.7	6.9
7	10:40:13	1.50	0.405	0.113	1.66	961.0	5.2
8	10:40:28	1.75	0.445	0.113	1.90	955.9	5.2
9	10:40:43	2.00	0.484	0.150	2.13	1268.1	6.9
10	10:40:58	2.25	0.528	0.075	2.38	630.4	3.5
11	10:41:13	2.50	0.563	0.075	2.59	627.5	3.5
12	10:41:28	2.75	0.599	0.262	2.80	2185.9	12.2
13	10:41:43	3.00	0.633	0.150	2.99	1243.6	6.9
14	10:41:58	3.25	0.669	0.075	3.20	618.9	3.5
15	10:42:13	3.50	0.704	0.113	3.40	924.1	5.2
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.

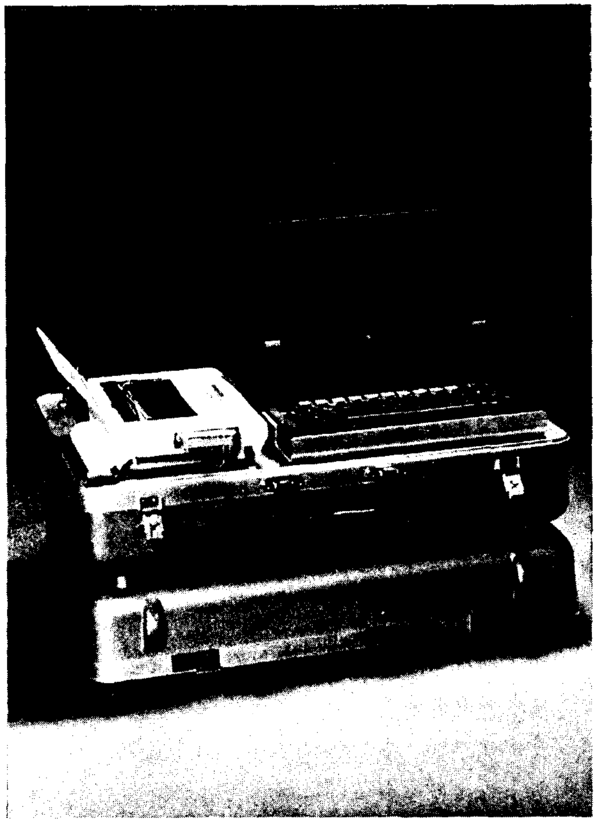

Figure 1 - Data acquisition system

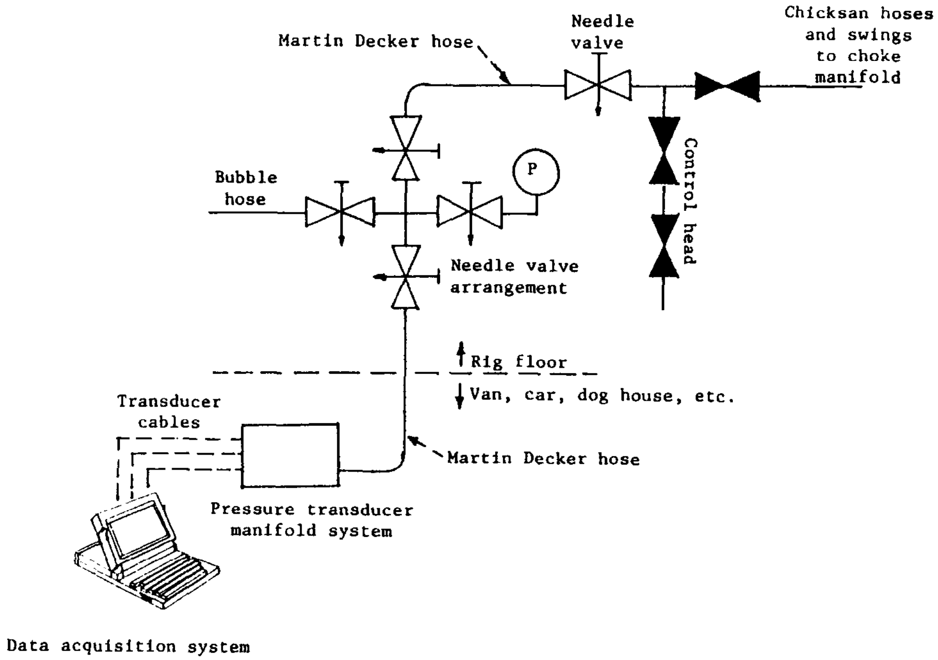

Figure 2 - Pressure manifold system

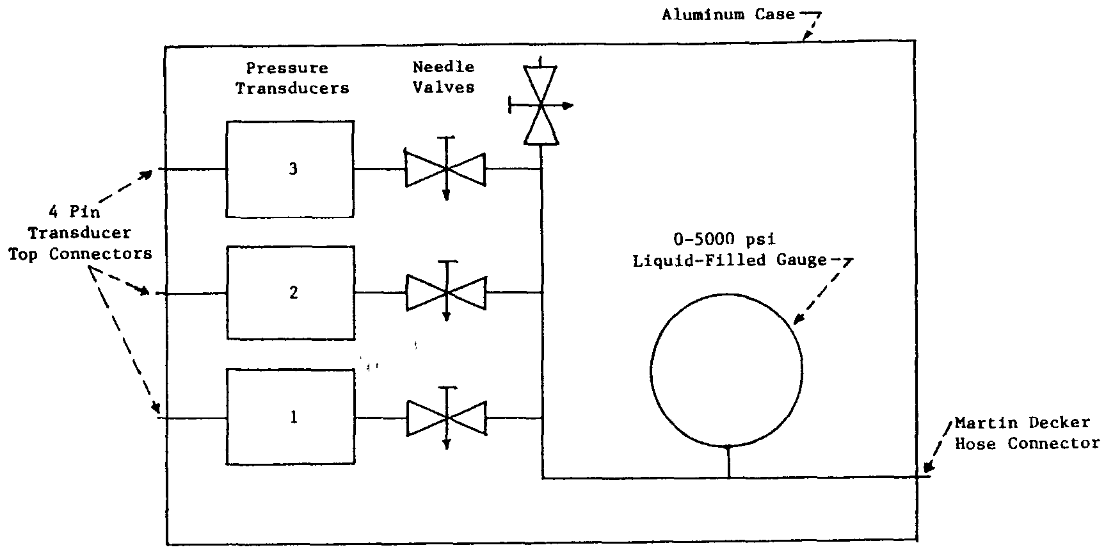

Figure 3 - Pressure transducer manifold system

```
CMDS >>  Continue
Scr: 1.00    ** INITIALIZATION **

        Index     Option
        -----     -------------------------
          1       Select Options
          2       Change Default Units
          3       Select Individual Units
          4       Enter Remarks
          5       Enter Pretest/Rate Data
          6       Enter Calibration Data

        Select Index (1-6) ==>
```

Figure 4 - Initialization menu

```
CMDS >>  Input  Menu
Scr: 1.05    ** PRETEST/RATE DATA **

Gross Tested Interval.......... <  7650.0> to <  7800.0> ft
Earth Surface Temperature...... <      60> F
Initial Surface Pressure....... <    14.7> psi (abs)
Estimated Reservoir Temperature <     150> F
Estimated Reservoir Pressure... <    3000> psi (abs)
Estimated Gas Gravity.......... <    0.60>
Effective Bottomhole Choke*.... < 0.75000> in
Depth to Tester Valve.......... <  7629.0> ft
Water Cushion.................. <  1212.5> ft
Drill Collar Inside Diameter... <  2.2500> in

                     Drill Pipe
         ------------------------------------
         Segment    Length     Inside Diameter
                     (ft)           (in)
            1     <  7208.0>   <  3.8260>  (Top)
            2     <        >   <        >
            3     <        >   <        >
            4     <        >   <        >
            5     <        >   <        >

* Not required if maximum rate curves are not requested.
```

Figure 5 - Pretest/rate data entry screen

```
CMDS >>  Input  Menu
Scr: 1.06    ** CALIBRATION **

             Surface Pressure
----------------------------------
Transducer      Zero          Span
  Number         (V)        (psi/V)
     1       < 1.00680>  <   12.50>
     2       < 0.96920>  <   62.50>
     3       < 1.01810>  <  750.00>

Initial Transducer Selection <1>
Interval Between Readings. < 15> sec
```

Figure 6 - Transducer calibration screen

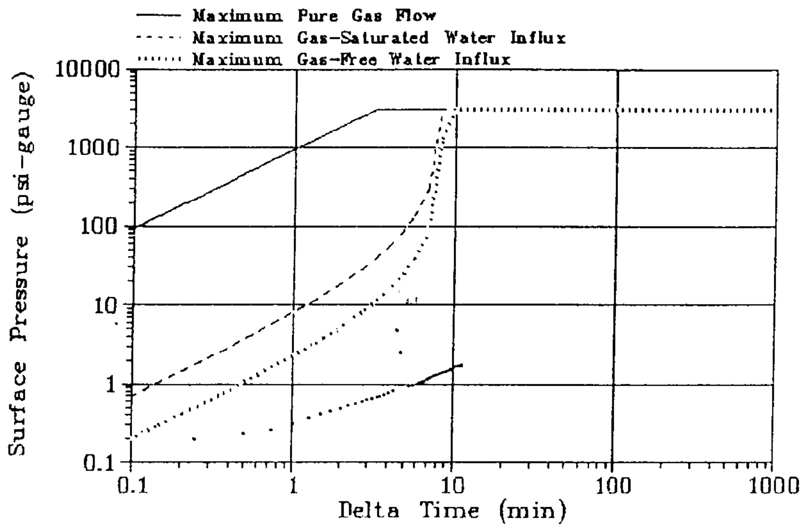

Figure 7 - Example pretest planning graph with data

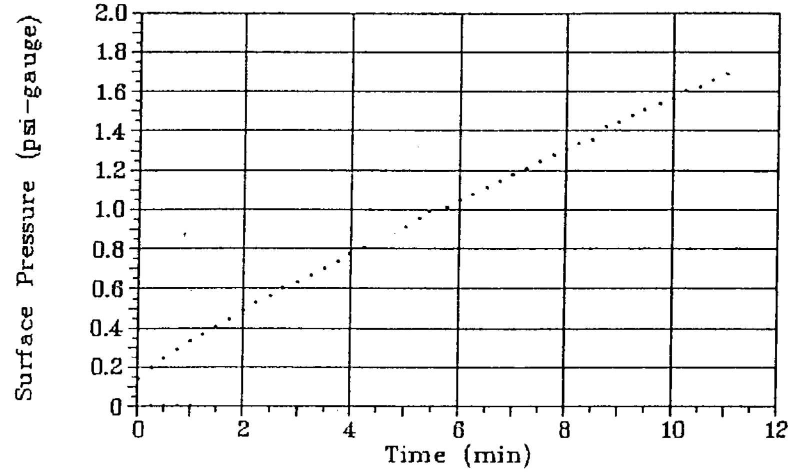

Figure 8 - Pressure vs. time graph

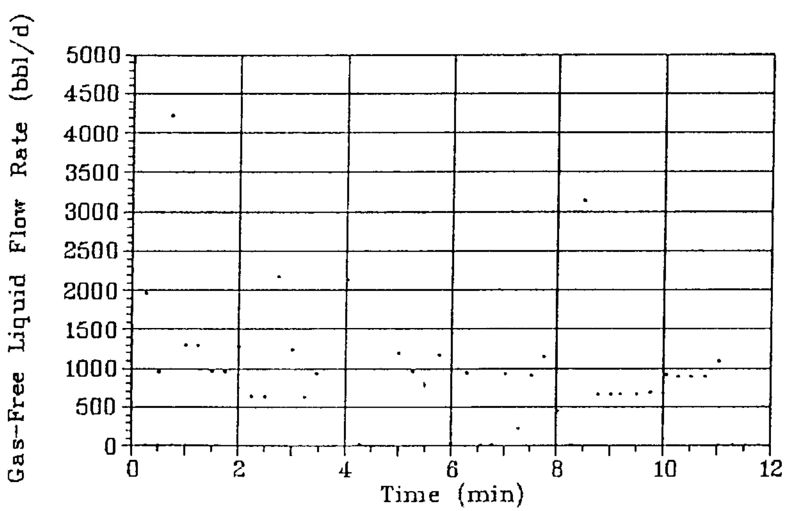

Figure 9 - Gas-free liquid flow rate vs. time graph

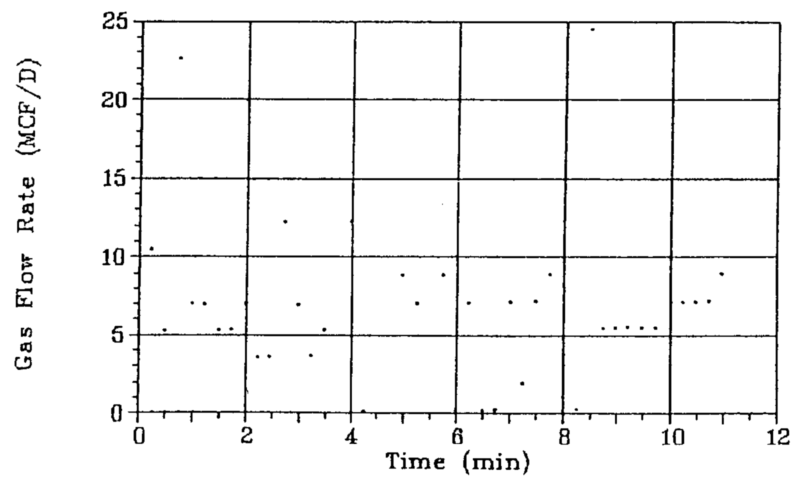

Figure 10 - Gas flow rate vs. time graph